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VESSELS FOR CONTAINING MOLTEN METAL

Abstract:

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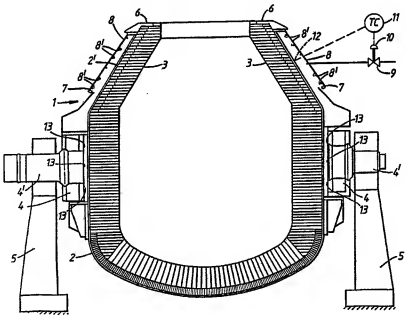

(57) Abstract

A vessel for containing molten metal comprises a metal shell. At least a part of the shell is cooled by having water droplets applied to the outer surface of the shell at a rate which does not exceed the rate at which the droplets are vaporised so that water does not run off the cooled surface into contact with the molten metal. Other metal bodies associated with the vessel can be cooled.

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VESSELS FOR CONTAINING MOLTEN METAL

This invention relates to vessels for containing molten metal and in particular to such vessels having means for cooling a metal body forming part of, or associated with, the vessel. The invention also relates to a method of cooling a hot metal body of such a vessel.

In pyro-metallurgical processes, heat is generated during the smelting, melting or refining of the metal. The process ingredients are usually confined within a steel vessel which is lined with refractory material in order to protect the steel shell, as far as possible, from the high temperatures used in the process. Nevertheless, the shell usually becomes hot so that it is beneficial to provide cooling of at least part of the shell in order that distortion is reduced and the shell material retains sufficient of its strength to operate according to the designer's intentions. In recent years, the use of Mag-Carbon as the lining material has given a longer working life to the lining but it has resulted in higher shell temperatures.

In conventional furnaces, water cooling is often used to cool the furnace shell and conduits or jackets are provided close to, or form part of, the shell structure through which cooling water is circulated. It is now well recognised in the

metallurgical industry that it is extremely dangerous to allow liquid water and liquid metal to come into close proximity to one another because, in the event of a fault occurring, the sudden expansion and vaporisation of water on contact with liquid metal can cause a dangerous explosion.

An object of the present invention is to provide a vessel for containing molten metal in which provision is made for cooling a body forming part of, or associated with, the vessel without the danger of significant quantities of water and liquid metal coming into contact with each other.

According to a first aspect of the present invention, in a method of cooling a hot metal body forming part of, or associated with, a vessel containing molten metal, droplets of liquid coolant are applied to the outer surface of the body in a controlled manner such that the volume of coolant applied in a given time period does not exceed the volume of coolant which is vaporised by contact with the hot surface in the given time period.

The liquid coolant is conveniently water and, since the water is applied in the form of droplets on to the outer surface of the shell, cooling by vaporisation takes place. In this way advantage can be taken of the fact that a much greater quantity of heat can be removed by each unit mass of water employed when it is vaporised than when it remains liquid. As the

water is applied at a rate not exceeding the rate at which the water is vaporised by contact with the hot surface, there is no water remaining to run off the surface being cooled into possible contact with the molten metal contained within the vessel.

According to a second aspect of the invention, a vessel having a metal body which forms part of the vessel, or is associated with it, and means for applying, in a controlled manner, droplets of liquid coolant to the outer surface of the metal body whereby, in use, with molten metal in the body, the volume of coolant applied in a given time period does not exceed the volume of coolant which is vaporised by contact with the hot metal surfaces in the given time period.

The metal body is ususally the shell of the vessel and the liquid coolant is supplied to the vicinity of the metal shell by way of tubes, pipes, headers and the like and the means for applying droplets to the outer surface of the shell to be cooled may take the form of nozzles which produce a very fine spray or they may comprise atomisers to which the liquid coolant and a compressed gas are supplied for the gas to break up the liquid coolant into very fine droplets.

In use, the amount of liquid coolant applied to the surface of the shell is controlled by means which determines the temperature of the outer surface

of the part of the shell to be cooled and valve means for controlling the supply of liquid coolant in response to the determined temperature such that the droplets which are applied over a time period do not exceed the droplets which are vaporised by contact with the surface during that period.

In order that the invention may be more readily understood, it will now be described, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 is a sectional side elevation of a basic oxygen furnace in accordance with the present invention;

Figure 2 is a section through a ladle furnace; and

Figure 3 is a section through an electric arc furnace.

Referring to Figure 1, a basic oxygen furnace 1 comprises a steel shell 2 having a lining 3 formed from blocks of refractory material. Shell 2 is carried in a trunnion ring 4 having a pair of horizontally disposed trunnions 4' which are, in turn, supported by pedestal bearings 5. The trunnions permit the furnace to be tilted about a horizontal axis to permit molten metal to be poured from the tap hole. At its mouth, the shell 2 is formed with a conical section 2' which is topped by a nose ring 6. The conical section of the shell is surrounded by slag shedder plates 7 which

protect the conical section of the shell 2' from slag and molten metal spilled from the mouth of the vessel.

In use, steel is refined in the refractory lined shell by blowing oxygen into a bath of liquid iron either through tuyeres (not shown) in the base of the furnace shell or on to the surface of the liquid iron through a water-cooled lance (not shown) projected into the furnace through its open mouth.

The shell of the vessel becomes very hot and it is not convenient to supply a water cooling jacket or conduit in the vicinity of the open mouth of the furnace in case a fault occurs and a substantial amount of water enters into the furnace to contact the molten metal therein.

According to the present invention, cooling is supplied to the conical section 2' of the shell by positioning a series of radial headers 8 around the outer periphery of the conical section 2' and water is supplied to these headers from a main supply 9 under the control of a valve 10. Each header 8 is in communication with a plurality of spray nozzles 8' which apply the water supplied to the headers on to the outer surface of the conical section 2' in the form of droplets. The spray nozzles produce droplets rather than providing a coherent curtain of liquid coolant on the surface of the vessel. The rate at which the droplets are applied to the surface is controlled such that the coolant is vaporised by contact with the hot

surface and the surface is not cooled to such an extent that water runs off the surface. The vaporised water and the gaseous discharge from the furnace are withdrawn through a fume pipe (not shown) positioned close to the mouth of the vessel. To control the amount of water applied to the shell, one or more thermocouples 12 are used to determine the temperature of the surface and this is transmitted to a temperature controller 11 which controls the supply of water passing through the valve 10.

By positioning the nozzles within the space between the conical section 2' and the slag shedder plate 7, some of the droplets of liquid coolant come into contact with the shedder plate to cool that also.

Further spray nozzles 13 can be provided in the region of the trunnion ring 4 for spraying droplets of water on to the outside of the shell 2. A similar method of temperature control can be used for these spray nozzles 13.

The spray nozzles 8 can be replaced by atomisers to which a supply of compressed gas and water is provided, the gas breaking up the water into very fine droplets.

The arrangement of the headers 8 and the nozzles 8', or atomisers when they are used, is such that the coolant is applied substantially uniformly over the entire surface of the part of the vessel which is to be cooled.

Referring to Figure 2, a ladle furnace comprises a steel shell 2 having a refractory lining 3. A lid 18 is fitted on to the ladle and electrodes 14 project through openings in the lid into the vessel for the production of an electric arc between them. The shell of the lid is provided with cooling means in the form of spray headers 8 which are supplied with liquid coolant from a supply main 9 via a control valve 10. The appparatus for cooling the lid and the method of operating the apparatus is as described with the embodiment of Figure 1.

Similarly, as shown in Figure 3, an electric arc furnace has a removable lid 18 comprising a metal shell with a refractory lining. In use, the lid is mounted over the base of the furnace and the electrodes 14 pass through openings in the lid of the furnace. When the furnace is to be tapped, the electrodes are withdrawn from the furnace and the lid is swung to one side. It will be appreciated, therefore, that, with a removable lid, the pipework associated with the cooling means should be as simple as possible. In accordance with the present invention, sprays 8' or atomisers are located relative to the surface of the lid so that cooling liquid can be applied in the form of droplets on to the surface of the lid. The amount of liquid which is supplied is controlled to ensure that substantially all the liquid is applied to the surface and there is no water which can run off the lid into

contact with the molten metal.

In an electric arc furnace, the upper ends of the electrodes are each contained within a metal tube which becomes very hot when the furnace is in use. The invention may be applied to cool these metal bodies.

Claims:

1. A method of cooling a hot metal body forming part of, or associated with, a vessel containing molten metal in which droplets of liquid coolant are applied to the outer surface of the body in a controlled manner such that the volume of coolant applied in a given time period does not exceed the volume of coolant which is vaporised by contact with the hot surface in the given time period.

2. A method as claimed in claim 1, in which the liquid coolant is water.

3. A method as claimed in claim 1 or 2, in which the liquid coolant is atomised by compressed gas to form said droplets.

4. A method as claimed in claim 1, 2 or 3, in which the surface is monitored and the liquid coolant is applied at a rate determined by the monitored temperature.

5. A vessel having a metal body which forms part of the vessel, or is associated with it, and means for applying, in a controlled manner, droplets of liquid coolant to the outer surface of the metal body whereby, in use, with molten metal in the body, the volume of coolant applied in a given time period does not exceed the volume of coolant which is vaporised by contact with the hot metal surfaces in the given time period.

6. A vessel as claimed in claim 5, in which the body constitutes the outer metal shell of the vessel.

7. A vessel as claimed in claim 5, in which the vessel is an arc furnace and the body surrounds, and is in contact with, one of the electrodes.

8. A vessel as claimed in claim 5, 6 or 7, including means for determining the temperature of the outer surface of the body and valve means for controlling the supply of liquid coolant to the surface in response to the determined temperature.

9. A vessel as claimed in claims 5 to 8, in which the means for applying droplets comprise spray nozzles.

10. A vessel as claimed in claims 5 to 8, in which the means for applying droplets comprise means for atomising the liquid coolant by compressed gas.

11. A vessel as claimed in claim 6, in which the surface of the shell to which the droplets are applied is spaced from a surface of another metal plate positioned outwardly thereof and the means for applying the droplets are positioned between the two surfaces so that some of the droplets are diverted on to the surface of the other metal plate.

12. A vessel as claimed in claim 5, in which the vessel is a basic oxygen furnace and the body to be cooled is a conical nose section of the shell.

13. A vessel as claimed in claim 5, in which the vessel is a ladle furnace and the part to be cooled is the lid.

14. A vessel as claimed in claim 5, in which the vessel is an electric arc furnace and the part to be cooled is the lid.

15. A vessel as claimed in claim 5, in which the body is a trunnion ring on the vessel.

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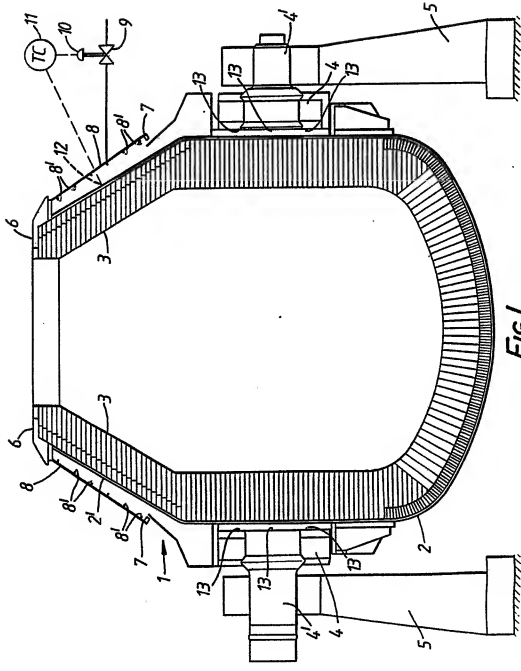

FIG. 1.

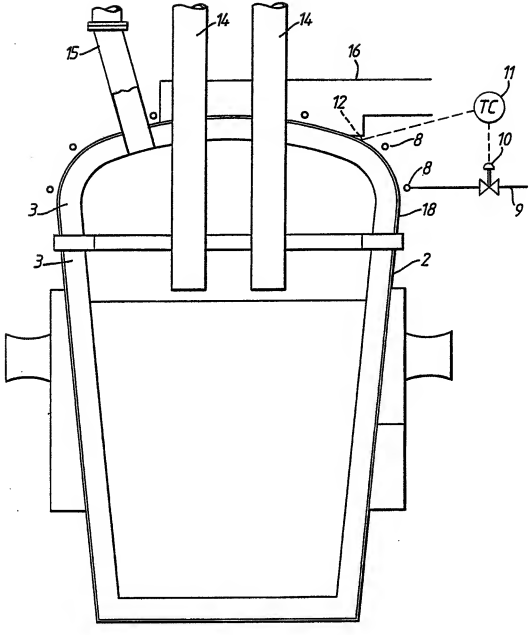

FIG. 2.

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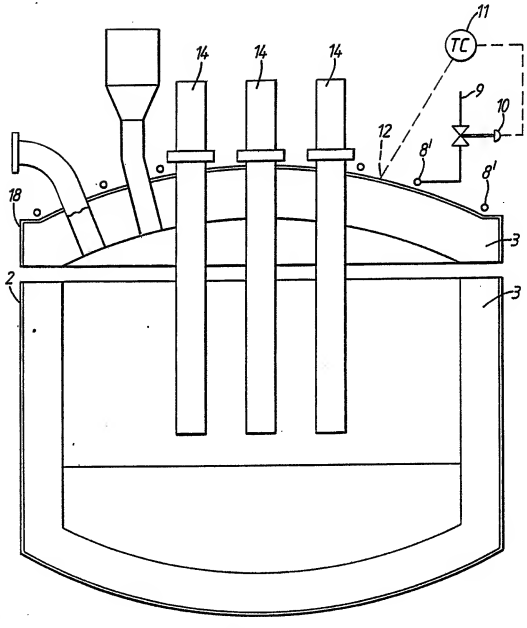

FIG. 3.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 88/00780

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: F 27 D 9/00; F 27 B 3/24; C 21 B 7/10

II. FIELDS SEARCHED

Minimum Documentation Searched [7]	
Classification System	Classification Symbols
IPC[4]	F 27 D; C 21 B; F 27 B

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	EP, A, 0044512 (KORF-STAHL AG) 27 January 1982 see claims; figures --	1-11,15
X	DE, A, 1043591 (STRICO) 13 November 1958 see claims; figures --	1-4,8-10
A	FR, A, 2468863 (MANNESMANN DEMAG AG) 8 May 1981 see claims; figures --	13
A	BE, A, 403754 (VEREINIGTE STAHLWERKE) 18 June 1974 see claims; figures --	
A	US, A, 4024764 (J. SHIPMAN) 24 May 1977 see claims; figures --	
A	FR, A, 1440807 (SOREM) 25 April 1966 see the abstract	

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
9th November 1988	29. 11. 88
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	P.C.G. VAN DER PUTTEN

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 8800780 SA 24390

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 23/11/88
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		CA-A- 1154066	20-09-83
BE-A- 403754		None	
US-A- 4024764	24-05-77	None	
FR-A- 1440807		None	